CHAPTER 5

PLOTTING RADIOLOGICAL FALLOUT AND CHEMICAL CONTAMINATION COVERAGE

INTRODUCTION

In military warfare operations, nuclear, biological, and chemical (NBC) weapons may be employed by either friendly or opposing forces with little warning. Marine Corps observers are the personnel that are primarily concerned with plotting nuclear fallout and chemical contamination areas ashore. However, due to the large number of Naval installations ashore and the increasing emphasis on joint operations between Army, Air Force, Marine, Special Operations, and Naval forces, naval weather observers must be familiar with plotting and predicting fallout and dispersion patterns for nuclear and chemical weapons both ashore and at sea. Biological weapons are of concern to Navy and Marine Corps operations, but the contamination hazard from these weapons depends on the methods used to deliver the agent. Biological agents are also very difficult to detect or predict.

NATO NBC REPORTING SYSTEM

LEARNING OBJECTIVES: Identify the publication that governs the NATO nuclear, biological, and chemical (NBC) warfare prediction and warning system. Identify the types of reports used in the NATO NBC prediction and warning system. Recognize the differences between NBC messages relating to ground forces and NBC messages relating to Naval forces.

The Allied Tactical Publication No. 45 (ATP-45), *Reporting Nuclear Detonations. Biological and Chemical Attacks, and Predicting and Warning of Associated Hazards and Hazard Areas,* covers in detail the procedures used by NATO forces to report nuclear, biological, or chemical weapons employment, and to estimate hazards associated with these weapons. The publication also provides detailed information on calculating and plotting nuclear, chemical, and biological hazard areas.

In the NATO system, six types of messages are used to report and track hazards associated with NBC weapons:

- NBC 1 (NUC, BIO, or CHEM)—initial report of NBC weapons use.
- NBC 2 (NUC, BIO, or CHEM)—follow-up report of evaluated data.
- NBC 3 (NUC, BIO, or CHEM)—effective downwind message.
- NBC 4 (NUC, BIO, or CHEM)—survey results.
- NBC 5 (NUC, BIO, or CHEM)—report of areas with contamination.
- NBC 6 (NUC, BIO, or CHEM)—report of details of chemical or biological attack.

When these messages are originated by Naval Forces, or composed specifically for transmission to Naval Forces, the abbreviation *NAV* precedes the report title, such as *NAV NBC 3 NUC.* Naval NBC messages use geographical coordinates for locations, nautical miles for distances, true degrees for directions, and knots for speeds. Ground forces, however, report all positions in (UTM) coordinates, distances in kilometers, directions in degrees or mils (see Appendix V), and speeds in kilometers per hour. All times are in Coordinated Universal Time (UTC). You must be able to convert between the systems of coordinates and measurements, as explained earlier in AG module 1.

PLOTTING RADIOLOGICAL FALLOUT

LEARNING OBJECTIVES: Plot nuclear hazard areas by using information in either an effective downwind forecast (EDF) or an actual NATO nuclear detonation effective downwind message (EDM). Identify the different types of nuclear bursts.

Radiological fallout patterns may be plotted using two types of products. In advance of any nuclear attack, a nuclear effective downwind forecast (EDF) provides general information to determine where and how far the

Manop Header with transmit time	
Title and Valid Time	
IX *A*dddFFFa *B*dddFFFa *C*dddFFFa *D*dddFFFa *E*dddFFFa *F*dddFFFa *G*dddFFFa	
FXEU21 EDZX 110915Z	Header
EFFECTIVE DOWNWIND MESSAGE ZULU 110600Z 11 JAN 1000Z - 1600Z	Valid Time
NL A004 - - - - B133009/ C134014/ D135016/ E136020/ F1530156 C1520206	1st area
NM A010010/ B142012/ C145017/ D150020/ E150021/ F160019/ G160022/	2nd area
	etc.

Figure 5-1.—Format and example of a typical Effective Downwind Forecast (EDF).

fallout will be carried. After a nuclear device has been detonated, and the actual weapon yield has been determined. a nuclear effective downwind message (EDM) provides specific predicted fallout areas for that weapon. Both types of products are discussed in the ATP-45. The following text discusses how to interpret the various types of nuclear effective downwind forecast products and the actual NBC 3 NUC reports.

NUCLEAR EFFECTIVE DOWNWIND FORECAST

Many computerized forecast centers routinely compose and transmit messages containing forecasts of effective nuclear fallout wind directions and speeds. When produced specifically for ground forces, the messages are entitled *Effective Downwind Message.* or *Effective Downwind Forecast*. When produced specifically for Naval Forces, the messages are entitled *Naval Effective Downwind Message* or *Naval Effective Downwind Forecasts.* For simplicity. we will call these products effective downwind forecasts (EDF). The primary difference between ground-force messages and naval messages is that naval messages give locations in geographical coordinates. distances in nautical miles. and wind speed in knots, while the messages for ground forces have locations in UTM coordinates, distances in meters or kilometers, and wind speeds in kilometers per hour. Figure 5-1 shows the standard EDF message format, and a typical EDF message.

In the message heading (fig. 5-1), the term *ZULU* precedes the date-time of the wind observation on which the forecast is based. In the format. the *IX* is the area indicator used to identify the two-letter UTM coordinate 100,000 meter-square grid, such as *NL* or *NM.* The letters *A* through *G* identify the yield groups. as shown in table 5-1. For each weapon-yield group. the *ddd* is the effective-downwind direction (direction

Table 5-1.—Yield Groups Used in Effective Downwind Forecasts

Yield GROUP	RANGE
A = ALPHA	2 kilotons (KT) or less
B = BRAVO	more than 2 kilotons (KT) to 5 kilotons (KT)
C = CHARLIE	more than 5 kilotons (KT) to 30 kilotons (KT)
D = DELTA	more than 30 kilotons (KT) to 100 kilotons (KT)
E = ECHO	more than 100 kilotons (KT) to 300 kilotons (KT)
F = FOXTROT	more than 300 kilotons (KT) to 1 megaton (MT)
G = GOLF	more than 1 megaton (MT) to 3 megatons (MT)

towards which the wind is blowing) in true degrees, while the *FFF* is the effective-downwind speed in kilometers per hour. The *a* is the expansion angle indicator, which is encoded as a "/" if only the 40° standard angle is to be used. Expansion angle indicators are provided in table 5-2. Predictions for several areas may be contained in a single message.

Table 5-2.—Expansion Angle Indicators

INDICATOR	EXPANSION ANGLE
/	40°
5	50°
6	60°
7	70°
8	80°
9	90°
0	100°
1	110°
2	120°
3	greater than 120°
-	CIRCLE AROUND GZ (wind speed less than 5 knots)

For a naval effective downwind forecast message (NAV EDM), the units used are slightly different. The area of validity, instead of being given as a UTM grid square, is provided as 5° latitude and longitude squares centered on the intersections of the latitude/longitude lines. For example, *2800N 09500W* represents a 5° square centered at 28° 00’N 095° 00’W. Directions are in true degrees, but all downwind distances are in nautical miles.

Additionally, the format may be different, depending on the organization producing the forecast. The yield groups *Alpha* through *Golf* may be listed in a vertical column instead of a horizontal row, as shown in figure 5-2. The first three digits are the effective downwind direction, while the last three digits are the effective downwind speed. The number in parenthesis is the expansion angle. In both ground force and naval force EDFs or EDMs, when the effective downwind speed is less than 8 KPH (5 knots), the radius of a circular fallout pattern is given by the first three digits, which are followed by three dashes.

Most of the effective downwind forecasts you will actually use are produced on site by the Tactical Environmental Support System (TESS). TESS calculates fallout patterns based on a specific weapon yield and input from a specified radiosonde data set. In addition to a dosage rate plot, TESS provides both English and Metric data similar to the NATO standard,

DFXX KNWC 111415Z

24HR NAVAL EFFECTIVE DOWNWIND FORECAST VALID 121200Z NOV 96

ZULU 111200Z

	3000N 12500W	3000N 12000W	3000N 11500W
ALPHA	130008	125008	005---
BRAVO	135010	130008	007---
CHARLIE	145015(060)	140012	135009
DELTA	155020(060)	150018(050)	145015
ECHO	160022(060)	155021(060)	150018
FOXTROT	180025(070)	175026(070)	170023(060)
GOLF	180030(070)	180029(070)	180026(060)

Each line element is composed as follows:

FOXTROT	180	025	(070)
yield group	downwind direction	downwind speed	expansion angle

Figure 5-2.—Typical Naval Effective Downwind Message (NAV EDM).

UNCLASSIFIED	RADFO ATP-45	OUTPUTS
		ENGLISH
CLOUD RADIUS	4.9	NM
EFFECTIVE DOWNWIND DIRECTION	135.	DEG
EFFECTIVE FALLOUT WIND SPEED	24	KNOTS
SECTOR ANGLE	40.	DEG
DISTANCE TO ZONE 1	52.8	NM
DEPOSITION BOUNDARY	1156.5 TO 1183.0	NM
		METRIC
CLOUD RADIUS	9.0	KM
EFFECTIVE DOWNWIND DIRECTION	135.	DEG
EFFECTIVE FALLOUT WIND SPEED	45	MIS
SECTOR ANGLE	40	DEG
DISTANCE TO ZONE 1	97.7	KM
DEPOSITION BOUNDARY	2041.6 TO 2190.7	KM
1018002 MAY97 2800N 09300W		UNCLASSIFIED

Figure 5-3.—Example of a TESS *RADFO ATP-45* output.

as discussed in ATP-45. Figure 5-3 shows a typical TESS *RADFO* (radiation fallout) output for a 200 KT weapon.

The effective downwind forecast message and the TESS outputs are used mostly for planning purposes. For example. a task force commander may ask what the fallout pattern would be if a 20 KT weapon were to be detonated at some location. You would either have TESS calculate the parameters for you using the latest upper-vvind data, or you would use an EDF containing the various yield groups for the area covering the specific location. The fallout pattern is then plotted on an appropriate chart. In this case, you would use the EDF message *CHARLIE* group. which is a forecast for all weapons in the 5-KT to 30-KT range. Keep in mind that the TESS *RADFO* program should not be used for high altitude bursts and deep-water bursts. The actual plotting procedure is discussed in the next section.

REVIEW QUESTIONS

Q1. What does the term "NBC warfare" mean?

Q2. What NATO publication outlines procedures for reporting and plotting NBC warning hazard areas?

Q3. How many types of NBC reporting messages are used and how do NBC messages for ground forces and NBC messages for naval forces differ?

Q4. What is the basic difference between an Effective Downwind Forecast (EDF) and an Effective Downwind Message (EDM)?

Q5. What does yield group "DELTA" indicate in an EDF message?

NUCLEAR EFFECTIVE DOWNWIND MESSAGE

Of the six NATO NBC reports previously mentioned, you will be primarily concerned with the *NAV NBC* 3 *NUC* or *NBC 3 NUC* when plotting nuclear fallout patterns.

When a report of evaluated information is composed for transmission to Naval Forces, it is entitled *NAV NBC 3 NUC*, and is referred to as a *Naval Effective Downwind Message*, or *NAV EDM* These messages provide positions in geographical coordinates, angular measurements in degrees true, distances in nautical miles, and speeds in knots. The *NAV NBC 3 NUC* report

NAV NBC 3 NUC	NBC 3 NUC	Description of Elements
A. 24	A. 24	A. Strike serial number.
D. 201405Z	D. 201405Z	D. Date-time of strike.
F. 5600N 01115E	F. 32VLB 126456	F. Coordinates of blast.
N. 10 KT	N. 10 KT	N. Weapon yield.
Y. 01000140 DEGREES	Y. GRID 17782489 MILS	Y. Clockwise direction of left fallout radial (4 digits), then the right fallout radial (4 digits).
Z. 01000804	Z. 01901508	Z. Effective downwind speed (3 digits), Zone 1 downwind distance (3 digits), and the cloud radius (2 digits).
NNNN	NNNN	
NOTE: When the wind speed is less than 8 KPH (5 knots), the Zone I downwind distance in element 'Z' will be reported in only 3 digits, which is the radius of the Zone I hazard from GZ.		

Figure 5-4.—Example of the contents of NATO reports *NAV NBC 3 NUC* and *NBC 3 NUC* effective downwind messages.

also contains evaluated information on the detonation, including weapon yield, effective fallout direction and speed, and cloud radius.

An *NBC 3 NUC* message of effective fallout downwind speed and direction for ground forces is called an *Effective Downwind Message*. In this message, locations are given in UTM coordinates, angular measurements in degrees or mils, distances in kilometers, and speeds in kilometers per hour. See figure 5-4.

PLOTTING RADIOLOGICAL FALLOUT AREAS

In the ATP-45, nuclear fallout is grouped into three categories:

- Immediate fallout—heavy debris deposited near ground zero within 1/2 hour of the blast.
- Medium Range fallout—debris deposited from 1/2 hour to 20 hours after a blast, up to hundreds of miles from g-round zero.
- Long Range fallout-very light particles that remain suspended in the atmosphere from 20 hours to several years. Fallout is deposited over a very large area of the earth's surface.

The NATO Nuclear fallout warning areas discussed in this chapter show only the areas that receive immediate and medium range fallout. The hazard to people in contaminated areas depends on the concentration of fallout, the amount of time the person has been in the contaminated area, and the total radiation the person has been exposed to over a period of time. Contaminated areas will remain radioactive for a considerable period of time on land, but the contamination is dispersed rapidly over water areas.

The quantity of fallout released by a blast is directly proportional to the size of the blast—a low-yield blast produces less fallout than a high-yield blast, and by the height of the blast. A high-air burst produces very little fallout, a low air-burst produces some fallout, and a surface-burst produces great amounts of fallout. At sea, a subsurface burst produces less fallout as the depth increases, with negligible fallout if the fireball does not break the surface. The effects of a nuclear blast are discussed in detail in your *Basic Military Requirements* course, as well as in *Military Requirements for Petty Officer Third Class.*

Figure 5-5 Shows a typical NATO fallout plot. The + marks the point where the weapon will be or has been detonated, identified by the letters *GZ* for *ground zero.*

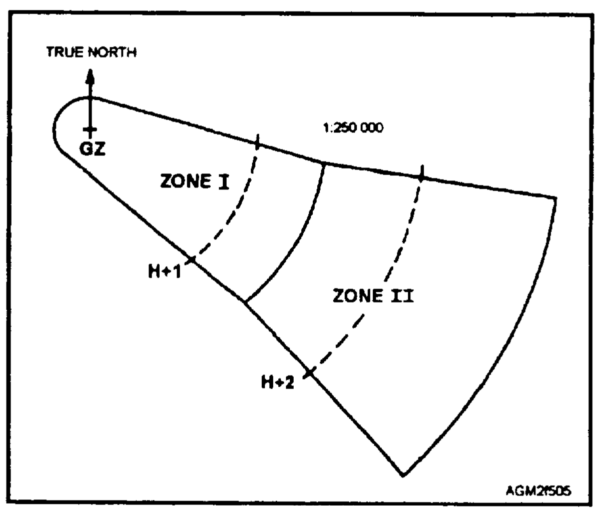


Figure 5-5.—NATO fallout plot.

The area marked *Zone I* is the Zone of Immediate Operational Concern. In this area, exposed, unprotected personnel will receive the maximum allowable emergency risk dose of 150 centi-grays (rads) of radiation in a time period from 0 to less than 4 hours after the arrival of fallout. The 4-hour figure is an estimate of how long it would take to pack up essential ground force military units (equipment and personnel) and evacuate an area as an intact and effective fighting force. Essentially, Zone I must be evacuated before a strike occurs, or the military units in the areas will suffer high personnel casualties and extensive loss of equipment and supplies.

The area marked as *Zone II* is the Zone of Secondary Hazard. Exposed, unprotected personnel may operate in this area between 4 hours and 24 hours after the arrival of fallout before receiving 150 centi-grays (cGy) of radiation. Essentially, military units in this area have the necessary time to pack up and evacuate after the arrival of fallout and remain effective as a fighting force.

Outside of Zone I and Zone II, some fallout will be received. However, military units may continue operating for up to 24 hours and be expected to receive less than 50 cGy radiation, and to operate for indefinite periods of time without receiving more than 150 cGy radiation.

To construct a NATO fallout diagram, follow these steps:

1. Locate ground zero (GZ) and mark it on your chart.

2. Draw the radial lines. Using information in a NAV NBC 3 NUC or NBC 3 NUC message, draw a straight line extending from GZ toward the directions indicated for the left and right radial lines. These directions are measured clockwise from true north when measurements are in degrees, or clockwise from grid north when measurements are in mils.

OR

Using information in the TESS RADFO output or an Effective Downwind Forecast, plot a line extending from GZ representing the Effective Downwind Direction. Then, plot the radial lines extending from GZ at 20° or one-half of the expansion angle right and left of the EDD line.

3. Draw the cloud radius. From the NBC 3 NUC or TESS output, determine the cloud radius. When using an Effective Downwind Forecast, obtain a representative cloud radius for the appropriate yield group from the table provided on the Ship's Fallout Template (fig. 5-6). Use a compass to set the radius on your chart's latitude scale (1 minute of latitude is 1 nautical mile) or grid scale, and draw the circle around ground zero.

4. Draw the Zone I boundary. TESS output: Set your compass to the *Distance to Zone I* using the latitude scale. NBC 3 NUC message: Set your compass to the Effective Downwind Distance, also using the latitude scale. Effective Downwind Forecast: Use the nomogram shown in figure 5-7, the actual weapon yield (or the maximum weapon yield if plotting a yield group for planning purposes) and the effective downwind speed provided by the forecast to calculate the Zone I downwind distance. Set the compass to this distance. With the compass point at GZ, draw an arc extending between the left- and right-radial lines. Use a straightedge to draw lines tangent to the cloud radius circle and the point of intersection of the radial lines and the Zone I boundary arc. Label the entire area within the cloud radius circle, the two tangent lines, and the Zone I arc as *ZONE I.*

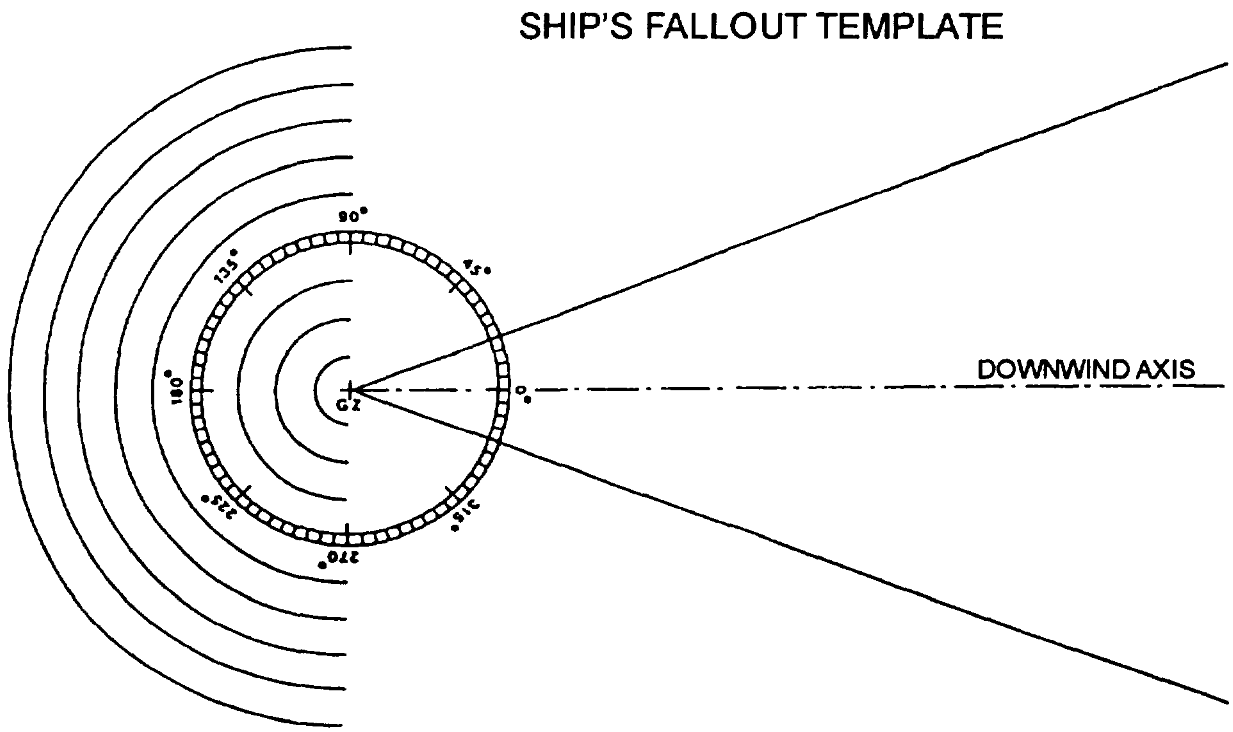
5. Draw the Zone II boundary. Double the Zone I downwind distance, and draw a second arc between the radial lines. Label the area enclosed between the radial lines and the Zone I and Zone II boundaries as *ZONE II.*

6. Draw the fallout arrival time arcs. The Effective Downwind Speed is the distance traveled by the fallout in 1 hour. Set your compass to the appropriate distance, place the compass point at GZ, and draw a dashed-line arc over the fallout plot. Label this line as *H+1,* for the arrival of fallout 1 hour after detonation. Double the distance on the compass and draw a second arc across the diagram. Label the second arc as *H+2.* Higher yield weapons may need an *H+3* arc. The effective downwind speed can also be determined by using the nomogram shown in figure 5-7.

7. When the effective downwind speed is less than 8 KPH (5 knots), the predicted fallout areas of Zone I and Zone II will be drawn circular around ground zero.

8. Finally, label the plot with the weapon yield, the date-time of the attack (or the valid period of the Effective Downwind Forecast), the location coordinates or name of the location, and the effective downwind speed and the UTC time (observation time of the upper winds used in the fallout prediction).

The NATO fallout plot (for any scale chart) can also be constructed by using the Ship's Fallout Template (fig. 5-6) or the three Land Fallout Templates that come with the ATP-45. The templates are transparent plastic diagrams with perforated holes used to place guide



	CLOUD RADIUS								SAFETY DISTANCE						
YIELD	A	B	C	D	E	F	G		A	B	C	D	E	F	G
NAUTICAL MILES	0.7	1.0	2.3	3.7	6.1	9.7	15		1.3	1.5	3.4	5	7	13	19
KILOMETERS	1.2	1.9	4.2	6.8	11.2	18	28		2.5	3.0	6.7	10	14	25	35

AGM2f506

Figure 5-6.—Ship's fallout template—a clear plastic template used to plot fallout diagrams on any scale chart.

marks on the underlying chart. Unlike the Land Fallout Templates, the semicircles upwind of GZ on the Ship's Fallout Template <u>do</u> <u>not</u> refer to specific weapon yields, but only serve as an aid in plotting. The 20° radial lines to the left and right of the downwind axis are not provided with units of measurement. In addition, since geographical charts used at sea are not uniformily scaled, the Ship's Fallout Template is unscaled. To use the Ship's Fallout Template, follow the steps outlined below.

1. Draw Grid North (downwind direction for appropriate weapon yield from NAV EDM) on the template from ground zero. Grid North is determined from a NAV NBC 3 NUC message by averaging the left and right radials from element "Y" of the message.

2. Plot the downwind distance to Zone I from element "Z" of the message or use the nomogram (fig. 5-7) to determine the downwind distance to Zone I. Double the distance to determine Zone II. Draw two arcs between the radial lines.

3. Determine the cloud radius from the Ship's Fall-out Template using the appropriate yield group from the NAV EDM. Element "Z" of a NAV NBC 3 NUC message will contain more accurate cloud radius data.

4. From the intersections of the Zone I arc with the radial lines, draw two more lines to connect the cloud radius circle.

5. To determine the area where deposition of fall-out is estimated to take place at a specific time, simply multiply the effective downwind speed by the time (in hours). Draw an arc between the two radial lines at the distance calculated. For example: 10 knots x 1.25 hours is 12.5 NM.

6. Add and subtract the safety distance as determined from the Ship's Fallout Template for the

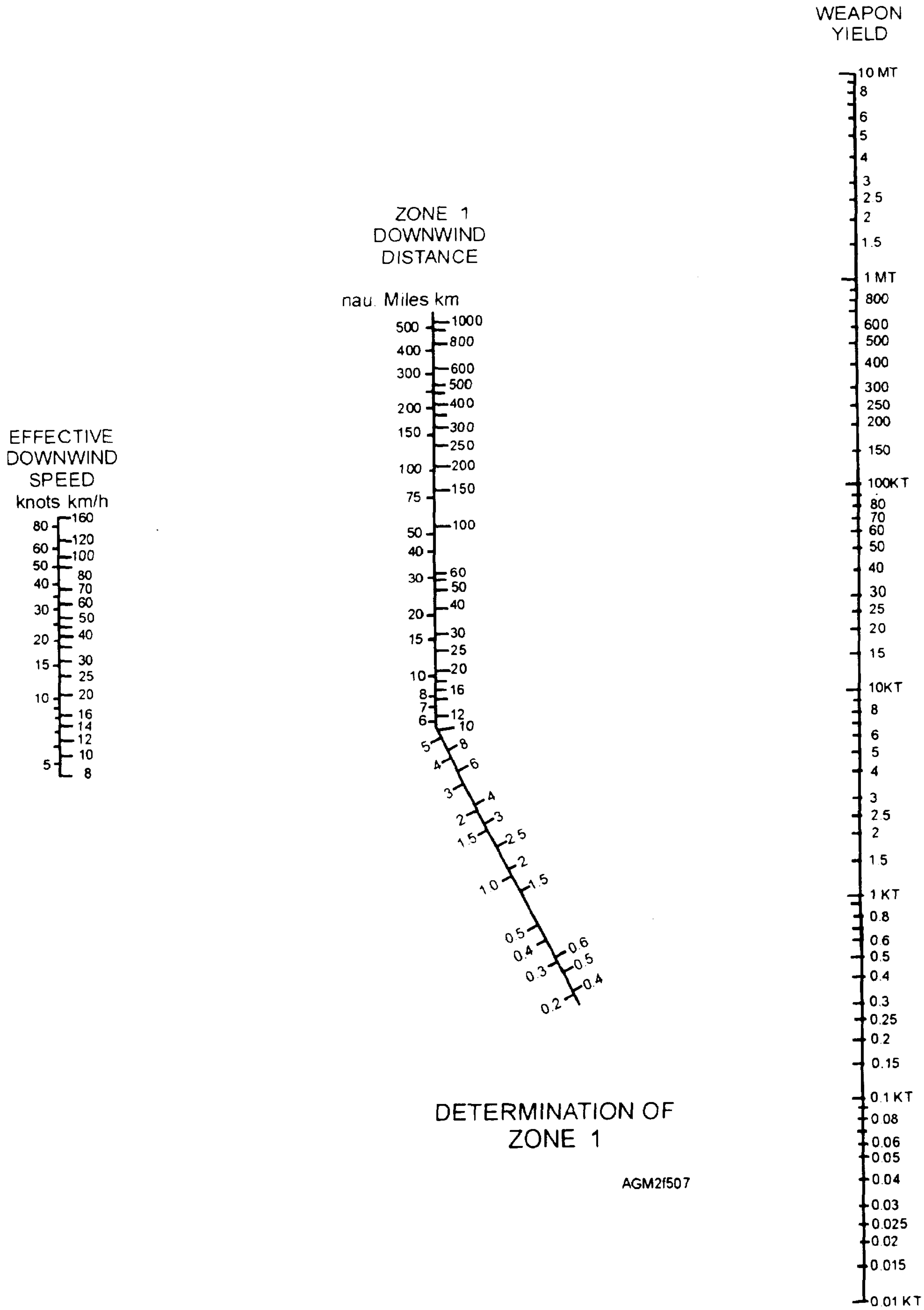


Figure 5-7.—Zone I downwind distance nomogram, used to calculate downwind distance from the effective downwind speed and weapon yield provided in an effective downwind forecast.

appropriate weapon yield, and draw two additional arcs across the fallout pattern. This is the area where fallout will be most heavily deposited.

7. When the effective downwind speed is less than 8 KPH (5 knots), the predicted fallout areas of Zone I and Zone II will be drawn circular around ground zero.

8. Complete the fallout plot by indicating the date-time of the message used, the yield and date-time of burst, ground zero position, and scale of chart used.

Figure 5-8 is an example of a completed fallout plot using the Ship's Fallout Template.

REVIEW QUESTIONS

Q6. What are the two types of radiological fallout messages of most concern to Aerographers?

Q7. What factors determine the extent and severity of a fallout contamination hazard area?

Q8. What type of nuclear burst produces the most fallout?

Q9. How are personnel operating in a NBC hazard Zone II affected by radiation?

Q10. What is the average cloud radius (NM) of a nuclear weapon in yield group "BRAVO"?

Q11. How is fallout arrival time determined?

Q12. Why is the Ship's Fallout Template unscaled?

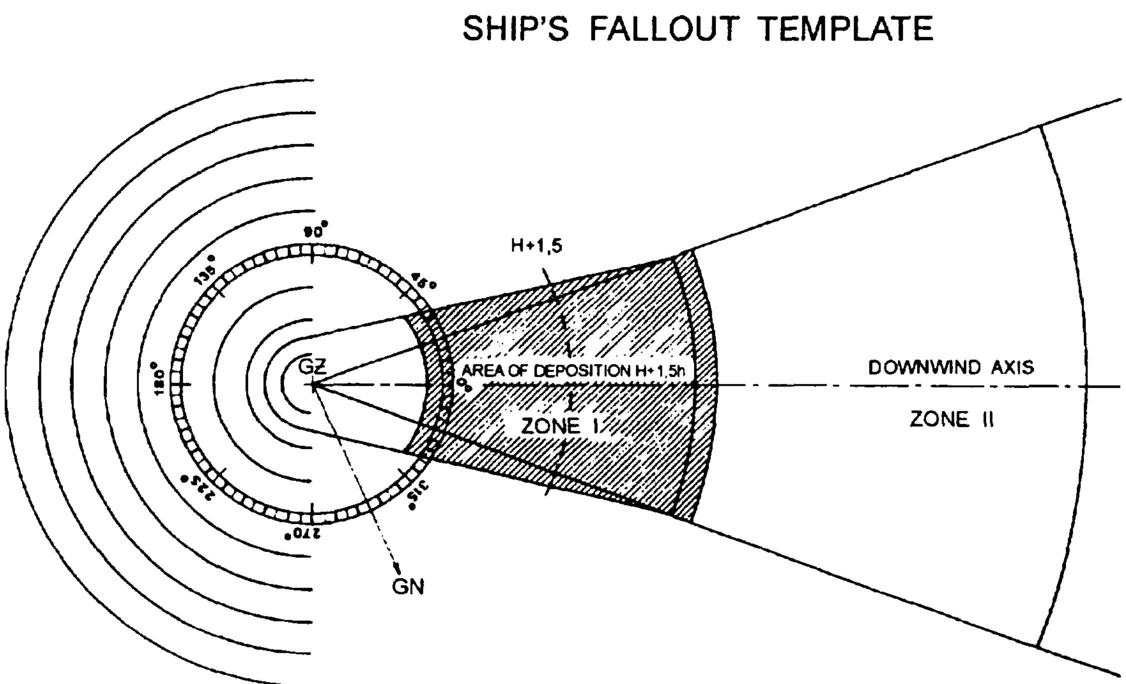
Q13. What information is contained in section "Z" of a NAV NBC 3 NUC message?

Q14. What is the safety distance (NM) for a 3.5 kiloton weapon?

Q15. When the effective downwind speed is less than 5 knots, how are nuclear fallout patterns plotted for hazard zones I and II?

PLOTTING CHEMICAL CONTAMINATION

LEARNING OBJECTIVES: Define terms associated with chemical warfare. Interpret the information provided in a NATO chemical downwind message (CDM). Plot the attack and hazard area for the three basic chemical contamination situations.



	CLOUD RADIUS								SAFETY DISTANCE						
YIELD	A	B	C	D	E	F	G		A	B	C	D	E	F	G
NAUTICAL MILES	0.7	1.0	2.3	3.7	6.1	9.7	15		1.3	1.5	3.4	5	7	13	19
KILOMETERS	1.2	1.9	4.2	6.8	11.2	18	28		2.5	3.0	6.7	10	14	25	36

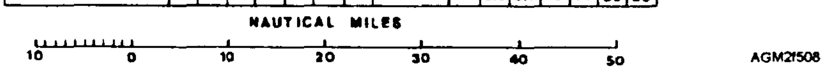


Figure 5-8.—Example of fallout plot using ship's fallout template.

Unlike nuclear fallout. the dispersal of chemical contamination is normally confined to a far smaller area, with much of the effects of the chemical depending on the local weather conditions. Considering the limited area effected by chemical weapons, any plot of chemical contamination is normally done only on the smaller scale charts, such as 1:50,000.

In amphibious battle situations supported by U.S. Naval ships and Marine Corps forces, you must prepare for the possibility that the opposing force will employ chemical weapons either against the ships or against the ground forces supported by your ship. The attack may come from bombs, rockets. or aerial spray. Accurate calculations for the area contaminated by the chemical agent are only possible after the agent has been identified. These calculations are preformed by forecasters or NBC evaluators following procedures detailed in ATP-45. Evaluated information is passed as a message following the NBC 3 CHEM format. As a Aerographer, you should be able to interpret a *NAV NBC 3 CHEM* or an *NBC 3 CHEM* report—the *Chemical Downwind Message,* and to plot the possible contamination area reported in the message.

Later, as you study to become a forecaster, you will learn about the format of a Chemical Downwind Forecast (CDF)—a product of basic forecast meteorological parameters used to evaluate how far downwind a particular chemical agent remains hazardous. CDFs are normally used by non-meteorological personnel at NBC centers to evaluate the duration and extent of chemical contamination for a specific chemical agent.

CHEMICAL WARFARE TERMS

Chemical agents may be spread by many means, such as bombs, mortar shells, artillery shells, rockets, missiles. mines. generator fog, or aircraft spray. The area where the chemical agent is released is called the *attack area.* The attack area includes a minimum radius of 1/2 nautical milc (at sea) or 1 kilometer (ashore) around the release site. This area is considered to be immediately contaminated because of the explosives distributing the agent or by the initial chemical spray.

Chemical agents are spread outward from the attack area by diffusion through the air and by mixing caused by the winds. The area contaminated by airborne chemical agents outside the attack area is called the *hazard area.* In situations involving calm or light winds (5 knots or less), the contamination is considered to spread outward from the attack area in all directions.

When the winds are greater than 5 knots, describing the hazard area is not as simple. Generally, the hazard area will form a triangular pattern. The contamination on the upwind side of the attack area is prevented because the contamination is carried with the wind toward the downwind side of the attack area. The information needed to describe the triangular pattern and the orientation of the hazard triangle is the chemical downwind direction, the downwind hazard distance, and the radial angles.

The direction the contamination is carried by the wind is called *the chemical downwind direction* (CDD). The CDD is 180 degrees opposite the surface-wind direction.

The distance the contamination is carried by the wind, outside the attack area, in high enough concentration to cause casualties, is called the *downwind hazard distance* (DHD), as shown in figure 5-9. The DHD depends on the type of agent, the means of delivery, the terrain, and the effects of the meteorological elements on the agent. The DHD is a minimum of 5 nautical miles (10 kilometers) and may extend up to 27 nautical miles (SO kilometers) from the center of the attack area.

Radials extend tangent from the edge of the attack area 30 degrees either side of the CDD ashore. At sea, 35° radial angles are used when the winds are between 5 and 10 knots, but only 20° radial angles are used when the winds are 10 knots or greater. The angles used to draw the radials account for variations in wind direction and horizontal diffusion of the chemical agent. These angles are referred to *as half-sector angles* (HSA).

The *chemical down windspeed* (CDS) is considered the same as the prevailing surface wind speed. However, calculations involving the time the leading edge of a chemical cloud arrives at a specific downwind location use a maximum speed of the CDS multiplied by 1.5 in order to account for variability in wind speed *or* gusty conditions.

One basic characteristic of a chemical agent that must be considered is the persistency of the agent—the tendency of the agent to vaporize to form a hazardous gas. *Non-persistent* (NP) *agents* are generally hazardous gases that remain in the target area for minutes or, in exceptional cases. for several hours after the attack. *Persistent* (P) *agents* are generally hazardous liquids which usually emit a hazardous vapor that remains in the target area for hours or days or, in exceptional cases, weeks after the attack.

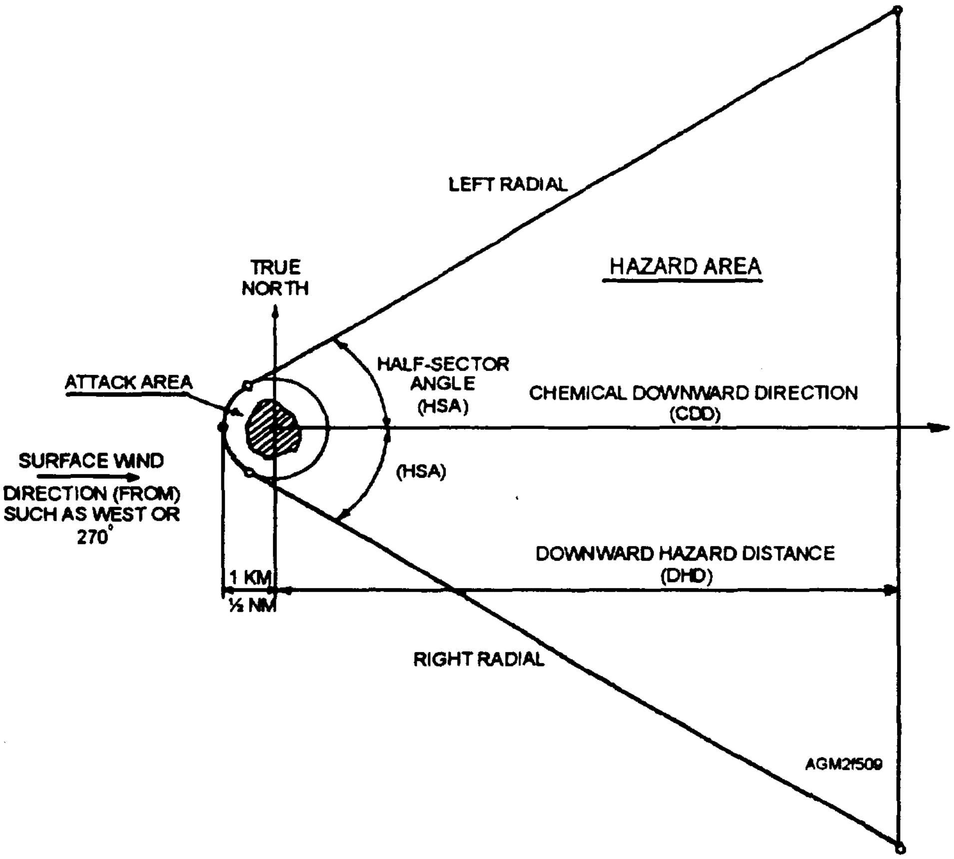


Figure 5-9.—Chemical contamination carried by the wind.

Some chemical agents are designed to contaminate the air and to cause disabling or lethal casualties when the vapor is breathed or contacts the skin or eyes. These are called *air-contaminating agents*. Air-contaminating agents generally form a gas cloud that moves with the wind currents. However, some chemical agents readily diffuse through the air and spread out from an attack area *even* in calm winds. Air-contaminating agents may be classified as either persistent or non-persistent. When an unknown type of chemical agent is used, it is always considered an air-contaminating agent until otherwise identified.

Other chemical agents (a solid or liquid) may be spread over an attack area to contaminate the ground and other surfaces. To some extent, the solids or liquids emit a hazardous vapor. Direct contact or close proximity to the contamination may cause disabling or lethal casualties. These types of agents are known as *ground-contaminating agents*. The normal downwind hazard distance of any ground contaminating agent used at sea is assumed to be 10 nautical miles.

Various chemical agents are known to be ready for use by countries that do not accept or ignore the Geneva Conventions agreement prohibiting the use of chemical weapons. After a chemical agent has been used in the field, the chemical may be classified by *agent groups* based on the effects of the agent on the human body. Agent groups include nerve, blister, blood, choking, incapacitating, irritant, and vomiting. Survey teams may perform tests to determine the composition of an agent. After testing, the agent may be identified by name, such as Tabun, Sarin, Soman, Mustard, or Lewisite. NBC protection, varying from use of gas masks to wearing complete NBC suits, depends on the agent group and specific agent employed. Further information on chemical agents and protection is contained in the *Military Requirements for Petty Officer Third Class* training manual.

When a suspected chemical weapon is employed against your location or ship, you first must complete personal and shipboard protective procedures. As the weather observer, you must then report current meteorological conditions to your shipboard Combat Information Center, or ashore, to Base Operations or the local NBC center.

Weather conditions that are required for the evaluation of the chemical agent downwind hazard distance (DHD) and the duration of the hazard are as follows:

- Wind direction and speed (degrees true and knots)
- Current air temperature and daily mean surface air temperature (°C)
- Relative humidity
- Total cloud cover (clear, scattered, broken, or overcast)
- Air stability (ashore)
- Air-sea temperature difference or sea-surface temperature (sea)
- Presence and type of any precipitation
- Presence of any temperature-inversion layers aloft with a base less than 1,500 feet

The elevation angle of the sun above the horizon is also an important value you may be asked to provide. However, the Quartermasters on the bridge may be able to determine this value faster and more accurately by measurement with a sextant.

Ashore, the air stability is determined by a *near surface temperature gradient*—difference between the surface air temperature and the air temperature at 100 meters (330 feet) AGL. The stability should be determined by your forecaster, as should the presence of temperature inversion layers aloft. The evaluated stability that the NBC evaluator needs is a statement of "stable" (any temperature increase or a decrease <l°C from surface to 100 meters), "neutral" (1°C decrease from surface to 100 meters), or "unstable" (>1°C decrease in the first 100 meters). As for elevated temperature inversions, the evaluator only needs to know if an elevated inversion is present below 1,500 feet.

At sea, a slightly different evaluation procedure is used. The difference between the air temperature and the sea-surface temperature (not necessarily the sea-water injection temperature) is used by the evaluator, along with the wind speed, to determine stability. The value required is T_{air} - $T_{sea\ surface}$. Negative values generally indicate unstable conditions, values near zero indicate neutral conditions, and positive values indicate stable conditions. Since this value is critical, the evaluator may request the sea-surface temperature, instead of or in addition to the air-sea temperature difference, to preform or check the calculation.

As long as your ship or unit remains in or near a hazard area, you must also monitor the winds. You must immediately report any significant changes in wind speed or direction to the forecaster or NBC evaluator. Significant changes include the following:

- Any change in the 2-minute wind speed of 5 knots or greater.
- Any change in the 2-minute wind speed decreasing to less than or increasing to more than 5 knots.
- Any change in the 2-minute wind direction of more than 20 degrees.
- Any change in the stability category, that is from stable to unstable or vice versa.

At sea or ashore, your activity may be tasked to maintain a chart of chemically contaminated areas. Unlike a standard weather chart, a single chart is used. It is updated by plotting new attack and hazard areas as attacks occur and by erasing or deleting old hazard areas or attack areas as the contamination decreases to safe levels. The duration of the hazardous contamination may be different within the attack area and the hazard area. This information. along with other critical evaluated information, may be provided by your forecaster or received from an NBC evaluation center-as a chemical downwind message.

REVIEW QUESTIONS

Q16. What is the minimum radius of a chemical warfare attack area from ground zero?

Q17. What is meant by the term "DHD"?

Q18. Given a wind speed of 16 knots, what would be the approximate downwind speed of the leading edge of the chemical cloud?

Q19. What is the assumed downwind hazard distance of a ground contaminating agent used against Naval Forces?

Q20. What meteorological parameters are required for a chemical hazard evaluation?

Q21. What would an air/sea temperature stability value of -5 indicate?

CHEMICAL DOWNWIND MESSAGE

The NBC 3 CHEM message, known as a *chemical downwind message,* is used to report evaluated information on the chemical agent employed in an attack and the area contaminated ashore (fig. 5-10). A NAV NBC 3 CHEM message is used to report similar information to Naval Forces.

NBC 3 CHEM	NAV NBC 3 CHEM	EXPLANATION
A. 002	A. 002	A: Strike serial number (optional).
D. 010903Z	D. 010903Z	D: UTC date-time of attack.
F. 32V UC250010 UTM ACTUAL	F. 240005N 0961321W DMS ACTUAL	F: Location of attack, estimated or actual.
G. MISSILE	G. MISSILE	G: Type of attack (aircraft. bomb, missile etc.)
H. NERVE, P, GROUND BURST	H. NERVE, NP, 200 FT	H: Type of agent, persistent (P) or Non-persistent (NP), and height of burst.
PA. UC248020 UC240015 UC240005 UC300900 UC370020 UTM	PA. 240105N 0961321W, TO 234005N 0955721W, TO 234005N 0962921W DMS	PA: Hazard area (military grid) or coordinates of outline of hazard area.
PB. ATTACK AREA 2-4 DAYS HAZARD AREA 1-2 DAYS	PB. ATTACK AREA 1 DAY HAZARD AREA 1 DAY	PB: Duration of hazard in days.
Y. 0120 DEG AT 008 KMH	Y. 0360 DEG 12 KNOTS	Y: Chemical downwind direction (4 digits in degrees or mils) and wind speed (kmh or knots).
ZA. 315962	ZA. 315962	ZA: Weather conditions used in evaluation of conditions in format bTTUwn
ZB. TYPE BRAVO, CASE ALPHA MAX DHD 010 KM	ZB. TYPE ALPHA CASE B MAX DHD 20 NM HSA 35 DEG	ZB: Type and case of chemical attack, max DHD, and HSA.

ZA. WEATHER CONDITION CODES in format *bTTUwn:*

b is the air stability code:
- 1 = very unstable
- 2 = unstable
- 3 = slightly unstable
- 4 = neutral
- 5 = slightly stable
- 6 = stable
- 7 = very stable

TT is the air temperature in whole °C. Add 50 to negative temperatures. (-10°C = 60)

U is the tens-value of the relative humidity.

w is the significant weather code:
- 0 for no significant weather,
- 3 for blowing snow, sand, or dust,
- 4 for haze or fog (vsby <4,000 meters),
- 5 for drizzle,
- 6 for rain,
- 7 for snow or mixed snow/rain,
- 8 for showers (rain, snow, or mixed),
- 9 for thunderstorms, with or without precip,
- S for elevated inversion layer.

n is the cloud coverage:
- 0 for clear, scattered or few.
- 1 for broken.
- 2 for overcast.

ZB. ATTACK TYPES AND CASES:

Type A: Air contaminating Agent
- Case a: Winds 5 knots (10 KM/H) or less.
- Case b: Winds more than 5 knots (10 KM/H).

Type B: Ground Contaminating Agent.
- Case a: Contamination within 1/2 nm radius circle.
- Case b: Contamination covers area radius between 1/2 nm and 1 nm.
- Case c: Contamination covers area greater than 1 nm in any direction.

Figure 5-10.—Chemical downwind message. Contents and explanation of an NBC 3 CHEM (ground forces) and in NAV NBC 3 CHEM (Naval Forces).

PLOTTING CHEMICAL CONTAMINATION DATA

Plotting chemical contamination areas is easy once you understand the terms and the contents of a chemical downwind message. Normally. the military grid squares contaminated by a chemical weapon are provided in element PAPA-ALFA of the chemical downwind message. In a NAV NBC 3 CHEM message, the contaminated area boundary positions should be provided in degrees, minutes, and seconds (DMS). A better picture of the contaminated area is constructed using other parameters contained in the message. From the NAV NBC 3 CHEM message, check element ZULU-BRAVO to determine the type and case of the attack. Element ZULU-ALFA contains environmental information, and, on occasion, plain language may be used in lieu of the meteorological reporting code. Now let's discuss the methods used to plot initial contamination for circular, triangular, and double-triangular hazard areas.

Circular Hazard Area

When winds are 5 knots or less in a type A-case (a) or a type B-case (a), case (b), or case (c) attack, the attack area is plotted as a circular hazard area. The important factor is that the prevailing wind speed is 5 knots or less. In both type A-case (a) and type B-case (a) attacks, the attack area *is* drawn as a 1/2-nautical-mile-radius (1-kilometer-radius) circle around the location where the chemical agent was deployed. In a type B-case (b.) attack, the attack area is drawn as a 1/2- to 1-nautical-mile-radius circle centered on the attack site and in a type B-case (c), the attack area is drawn larger than a 1-nautical-mile radius, depending on the type of attack. In all of these situations, the hazard area is a 10-kilometer-radius circle around the attack area for

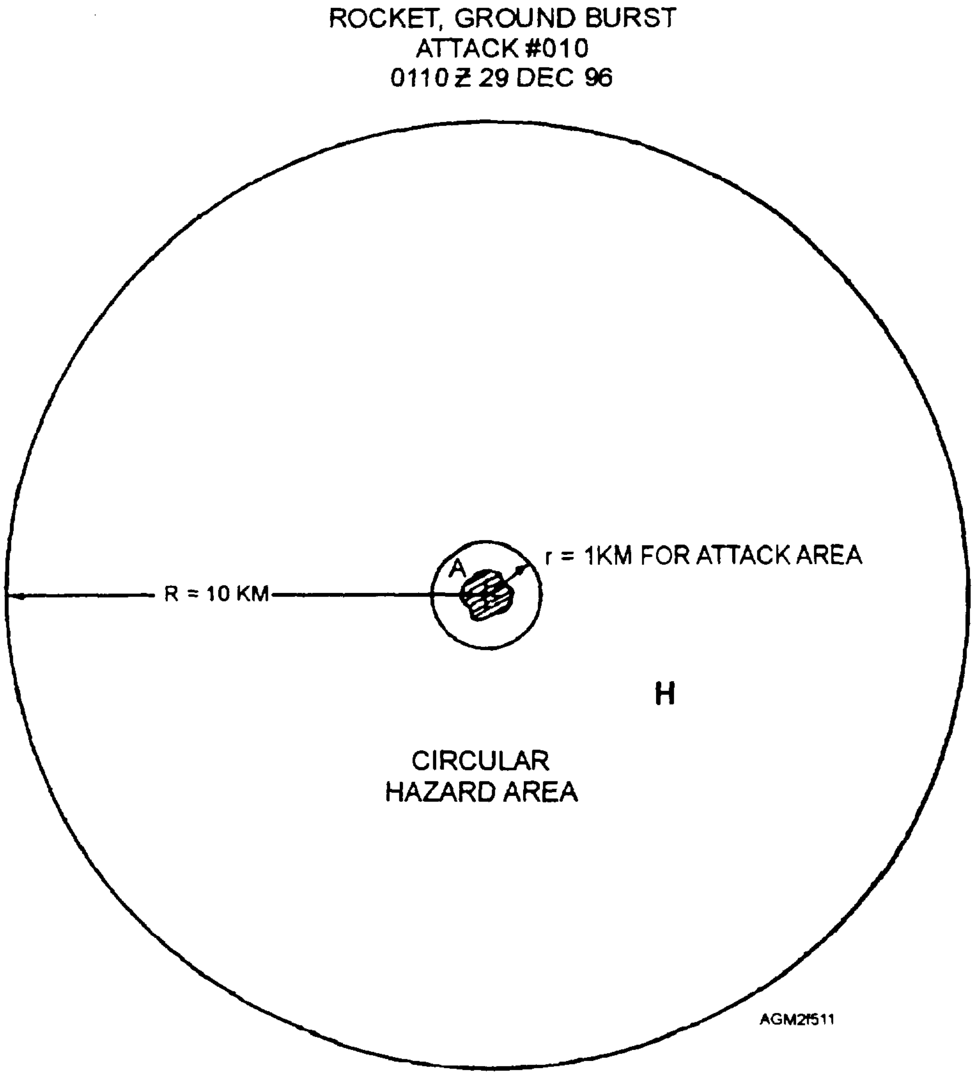


Figure 5-11.—Circular hazard area. Plotted type B-case (a) chemical attack, land. Wind speed 10 KPH/5 kt or less.

ground forces, and a maximum of 15-nautical-mile radius for Naval Forces.

From the NAV NBC 3 CHEM message, element FOXTROT, locate and mark the attack coordinates on your chart. Using a compass, set the distance between the points to 30 seconds of latitude (1/2 nautical mile), and draw a circle of this radius around the detonation point, Label the area within this circle *"A,"* for the *attack area*. Then set the compass spacing to 15 minutes of latitude. and draw a second circle with that radius around the detonation point. Label the area within this circle as *"H,"* for the *hazard area*. Near the circle, you should note the attack serial number and the date-time of the attack. The NAV NBC 3 CHEM message should either be kept with the chart or all of the other information should be noted on the chart (fig. 5-11).

Triangular Hazard Area

When the winds are greater than 5 knots in a type A-case (b) or type B-case (a) or case(b) attack, the plotted hazard area will generally be a triangular pattern with a circular attack area at the apex. The area is plotted as follows:

1. From the NAV NBC 3 CHEM message, locate the detonation point and mark this on your chart.

2. Now draw a light line through the point in the direction given by the chemical downwind direction (element YOKE). The line should extend through the **point** for just over 1 nautical mile in the upwind direction and up to 27 nautical miles in the downwind direction, as long as the downwind hazard distance (DHD).

3. From element ZEBRA-BRAVO, obtain the DHD. Measure the DHD from the center of the detonation downwind on the CDD line, and mark the distance on the line.

4. Now use a compass to draw a 1/2 nautical mile radius circle around the detonation point for either a type A, case (b) or a type B, case (a) attack, or a 1 nautical mile radius circle for a type B, case (b) attack. Label the area within the circle *"A,"* for *attack area.*

5. From element ZEBRA-BRAVO, determine the half-sector angle (HSA). If not given, the HSA is 30 degrees. Using a protractor on the segment of the CDD line on the upwind side of the detonation point, and the HSA angle, draw two radial lines tangent to the attack area boundary circle: one at the HSA angle to the left of the CDD line, the second at the HSA angle to the right of the CDD line (fig. 5-12).

6. Now draw a line perpendicular to the CDD line at the downwind hazard distance (DHD) marked earlier.

7. Label the triangular area extending downwind from the attack area as *"H,"* for *hazard area.*

8. Transfer all information from the NAV NBC 3 CHEM message to the chart.

NOTE: Instead of using a protractor to measure the HSA angles, you may construct a reusable template with 20-, 30-, and 35-degree HSA angles. Instructions for construction and use of the template are provided in the ATP-45.

Double-Triangular Hazard Area

When chemical contamination is dispersed over an elongated area, such as would occur during an aircraft spray attack, the resulting hazard area is plotted as two connected triangular areas. In the case of an aerial spray attack, it is assumed that the width of attack area is greater than 2 kilometers (1 nautical mile) wide. Normally, only ground-contaminating agents are used with an aerial spray. Once the agent settles on the ground, the vapor released by the liquid or solid agent drifts downwind. This hazard area is normally associated with a type B-case (c) chemical attack.

When the attack location is provided as a series of coordinates in element FOXTROT, or two coordinates

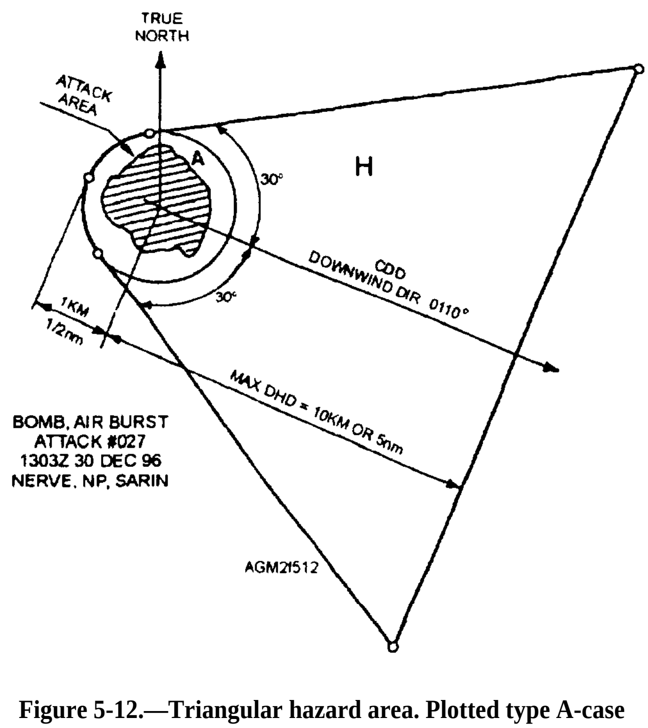


Figure 5-12.—Triangular hazard area. Plotted type A-case (b) chemical attack.

with a "to" or “through” statement (such as "point *A* to point *B"*), plot the attack area as follows:

- Draw %-nautical-mile-radius circles at both the beginning and end points in a spray line. Regard the two circles as being two separate attack areas.

- Draw two tangent lines connecting the circles (one upwind and one downwind).

As shown in figure 5-13, the hazard area is plotted by drawing a line representing the chemical downwind direction from the center of both circles, representing the beginning and ending points of the attack. Mark the DHD on each CDD line. Usually, the DHD for a ground-contaminating agent is 10 nautical miles; however, check element ZEBRA-BRAVO and use the DHD provided. Draw two radial lines tangent to each circle using the half-sector angle given in the message (or 30°). Draw lines perpendicular to the CDD lines at the marked DHD to form two triangular areas. Connect the apexes of the two resulting triangular hazard areas between points A and B, as shown to complete the hazard area.

The three situations we have discussed represent the basic plots of different hazard areas that could result from a chemical attack. Changes in wind speed and/or wind direction may require a reevaluation of the hazard area boundaries. Reevaluation is normally done by the forecaster or the personnel in the NBC center, and a supplemental NAV NBC 3 CHEM message is normally transmitted to cover the new areas. When a reevaluated NBC message is received with the same attack serial number and date-time of the attack message that has already been plotted, you should plot the new boundaries over the old hazard boundaries, possibly in a different color, and note the new information alongside the plot.

REVIEW QUESTIONS

Q22. What are the two types of chemical hazard messages of most concern to Aerographers?

Q23. What information is contained in element "PA" of an NBC 3 CHEM message?

Q24. What information is contained in element "ZB" of a NAV NBC 3 CHEM message?

Q25. What would the code "217981" indicate in element "ZA" of a NAV NBC 3 CHEM message?

Q26. How should a chemical hazard area be plotted for a Type "A" attack when the average wind speed is 5 knots or less?

Q27. What information must be obtained from an NBC 3 CHEM message in order to plot a triangular chemical hazard area?

Q28. When is a double triangular chemical hazard area plotted?

SUMMARY

There are several different types of messages related to NBC warfare. Various graphic products can be completed from these messages for NBC planning and briefing purposes. Most of these products can be rapidly produced from TESS. In this chapter, we have discussed the terms used to describe various aspects of NBC warfare and discussed in detail the elements of NBC messages you are most likely to encounter. We also described the manual methods for producing NBC hazard prediction plots.

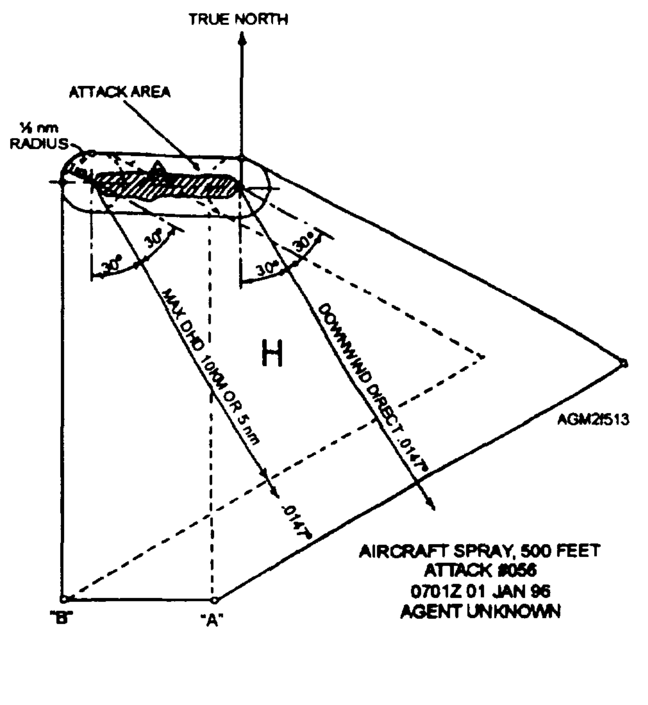


Figure 5-13.—Double-triangular hazard area. Plotted type B-case (c) chemical attack.

ANSWERS TO REVIEW QUESTIONS

A1. Nuclear, biological, and chemical warfare.

A2. Allied Tactical Publication (ATP) 45. Reporting Nuclear Detonations. Biological and Chemical Attacks, and Predicting and Warning of Associated Hazards and Hazard Areas.

A3. There are six types of NBC messages. Ground forces report information using grid coordinates, distances in kilometers. and wind speeds in KPH while Naval Forces use geographical coordinates, distances in nautical miles, and wind speeds in knots.

A4. An EDF is an Effective Downwind Forecast used for planning purposes. An EDM is an Effective Downwind Message that is transmitted after an actual nuclear detonation, providing more specific fallout prediction areas.

A5. The wind direction, downwind speed, and the expansion angle for nuclear weapons of more than 30 kilotons and up to 100 kilotons.

A6. NBC 3 NUC, an effective downwind message for ground forces and a NAV NBC 3 NUC, an effective downwind message for Naval Forces.

A7. The amount of fallout depends on the weapon yield and the type of burst. The amount of personal contamination depends on the concentration of the fallout. the amount of time the person has been in the contaminated area, and the total radiation the person has been exposed to over a period of time.

A8. A surface burst.

A9. Exposed, unprotected personnel may operate in hazard Zone II between 4 and 24 hours after the arrival of fallout before receiving dangerous dosages of radiation.

A10. 1 nautical mile.

A11. The effective downwind speed is the distance traveled by the fallout in 1 hour. It may be calculated for any specific time and distance using the estimated wind speed.

A12. The Ship's Fallout Template is unscaled since geographical charts used at sea are not uniformly scaled.

A13. Effective downwind speed (knots), downwind distance of Zone I (nautical miles), and cloud radius (nautical miles).

A14. 5 nautical miles.

A15. Zone I and Zone II are drawn as circular patterns from GZ.

A16. 1 kilometer for ground forces and 1/2 nautical mile for Naval Forces.

A17. DHD is the Downwind Hazard Distance- the distance the contamination hazard will travel dependent on the weapon type, method of delivery, terrain, and the meteorological conditions.

A18. 24 knots.

A19. 10 nautical miles.

A20. Wind speed and direction, air temperature, mean daily surface temperature, relative humidity, total cloud cover, air stability/air-sea temperature difference, presence and type of precipitation, and the presence of temperature inversion layers.

A21. Unstable conditions.

A22. NBC 3 CHEM, chemical downwind message for ground forces and NAV NBC 3 CHEM, chemical downwind message for Naval Forces.

A23. The hazard area (grid reference or geographical reference).

A24. Type and case of chemical attack, maximum downwind hazard distance, and half sector angle.

A25. Unstable air, temperature 17°C. relative humidity of between 90% and 99%. rain showers, and broken cloud cover.

A26. In a circle, I kilometer (1/2 nautical mile) from ground zero for the attack area, and 10 kilometers from ground zero for the hazard area (ground forces) or 15 nautical miles (Naval Forces).

A27. The location of the attack, the Chemical Downwind Direction (CDD). the Downwind Hazard Distance (DHD), and the Half Sector Angle (HSA).

A28. In chemical spray attacks from aircraft when the hazard area will most likely be in an elongated pattern.